

## SOIL SURVEY OF POTTAWATTAMIE COUNTY, IOWA.

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### DESCRIPTION OF THE AREA.

Pottawattamie County is situated in the southwestern part of Iowa, in the third tier of counties north of the Missouri State line. It is bounded on the north by Harrison and Shelby Counties, on the east by Cass County, on the south by Montgomery and Mills Counties, and on the west by the Missouri River and Nebraska. Its greatest length from east to west is  $44\frac{1}{2}$  miles, and its width north and south 24 miles. It contains 24 full townships and 5 fractional townships. It is the second largest county in Iowa, comprising a total area of 957 square miles, or 612,480 acres.

About three-fourths of the county consists of smoothly rolling to hilly loessial uplands, and the remaining 27 per cent of the area consists of flat to very gently undulating alluvial plains, mostly first bottoms.

The immediate valley of the Missouri River is deep, flat-floored, and sharply outlined by steep slopes and bluffs rising to a height of 100 to 300 feet. It averages 3 to 8 miles in width, while on the Pottawattamie County side it ranges from one-fourth mile wide north of Council Bluffs, where the river almost touches the bluffs, to  $3\frac{3}{4}$  miles wide along the northern boundary and to 6 miles in the southern part. Eastward from the Missouri bottoms there is a succession of creek and small-river valleys crossing the county in a generally parallel direction slightly west of south and strips of alluvial land occur in all of these, as well as along the numerous lateral streams ramifying through all sections between the main creeks. The escarpment or bluffs along the Missouri River and a belt one-half mile to 3 miles wide back from the bluffs are very badly dissected as the result of erosion and the surface is quite hilly and rough, with a considerable proportion of the land too steep for cultivation; but from the rougher bluff lands eastward there is a rapid change to the characteristic smooth, rolling topography of the central and eastern portions of the county. While the main body of the uplands appears as a succession of smooth, rounded hills and ridges rising one

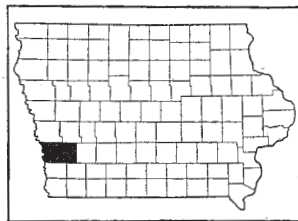


FIG. 47.—Sketch map showing location of the Pottawattamie County area, Iowa.

after another without any orderly arrangement, it is apparent from the accompanying map that there is a series of ridges alternating with the north-and-south valleys across the county. The ridge development, however, is not a conspicuous feature in the general landscape, as the slopes are very irregular and the ridge crests are well rounded and very sinuous in outline.

The higher outstanding ridges of the county outline an ancient plain which has an elevation of 1,100 to 1,300 feet above sea level. In the Missouri River bottoms the general elevation is from 970 to 1,010 feet above sea level. The elevation above sea level at Loveland, in the northwest corner of the county, is 1,007 feet; at Walnut, in the northeast corner, 1,293 feet; in Waveland Township, in the southeast corner, 1,200 feet; and in Keg Creek Township, in the southwest corner, 1,150 feet.

The county as a whole is drained toward the southwest through the main tributaries of the Missouri River, including Boyer and East and West Nishnabotna Rivers, and Mosquito and Pigeon Creeks. The overflowed bottom lands along these drainage ways are comparatively wide and comprise some of the most fertile lands in the county.

The streams of the county have worked out an intricate drainage system, probably on account of the loose character of the loess soils.

Pottawattamie County has good transportation facilities. Through lines of the Chicago, Rock Island & Pacific; the Chicago, Milwaukee & St. Paul; and the Chicago Great Western, between Omaha and Chicago, extend from Council Bluffs along the Mosquito Valley, the Rock Island serving the four east townships of the northern tier. Main lines of the Illinois Central and Chicago & North Western run north along the Missouri lowlands. From Council Bluffs the Wabash Railroad leads southeast to St. Louis, and the Chicago, Burlington & Quincy south to St. Joseph and Kansas City. The Iowa & Omaha Short Line connects Council Bluffs and Treynor. From Avoca, in the northeastern part, the Rock Island has a line south along the Nishnabotna to Carson, whence the Burlington Route operates south. All the lines afford communication with Omaha, across the Missouri River. Seven or eight miles is about the distance of the most remote point from a railroad.

Pottawattamie County had a population of 55,832 in 1910. Council Bluffs, with 29,292 people, is the metropolis. It is one of the county seats, Avoca, population 1,520, being the other. Some of the other towns are Oakland, Walnut, Neola, Minden, Underwood, Carson, Macedonia, Hancock, and Treynor. All these towns are incorporated. Oakland, the largest, has a population of 1,105.

A large percentage of the population of the county is of foreign descent, many of the best farmers being of German, Norwegian, Swedish, and Danish descent.

The public roads and bridges throughout the county are under the administration of a county engineer, who is under the supervision of the State highway commission. The county is crossed by two State highways and one transcontinental highway, the White Pole Road, the River-to-River Road, and the Lincoln Highway. The main public roads are dragged after every hard rain and are kept in excellent condition during the greater part of the year.

The public-school system of the county is good. The rural schools are located approximately 2 miles apart, while all the towns have high schools, grades 9 to 12. A number of rural schools have been consolidated, and the pupils are transported to and from these schools in public conveyances.

#### CLIMATE.

The climate of Pottawattamie County is continental and characterized by wide ranges in temperature, with cold winters and hot summers. There is a large percentage of sunshine. The county lies in the general path of the cyclonic and anticyclonic storm movement across the United States.

The mean annual rainfall of 30.8 inches is very favorably distributed for crop planting, plant growth, and harvesting. During the winter months of December, January, and February the precipitation averages only 0.8 inch each. It occurs, however, mostly in the form of snow, which protects winter grain and prevents washing and leaching of plowed soils. During the spring months about three-tenths of the year's rain falls. During the main growing season—June, July, and August—not much less than half the annual rain comes. The monthly precipitation becomes gradually lighter from June on, and for November the average is only 1 inch. The year's precipitation is sufficient, with proper conservational methods, for all the common crops, and they seldom suffer for lack of moisture. Most of the rainfall comes in the form of gentle showers, but occasionally, during the passage of a cyclonic area from the southwest to the Lakes, the rain is general over the State and several days in duration. Many of the summer showers are thunderstorms, and they are sometimes attended by heavy downpours, hail, and wind squalls, local in extent.

The mean annual temperature of Pottawattamie County is 50° F. The mean for winter is 24° F. A temperature of -32° F. has been recorded in January. During the winter blizzards occur at times, when snow falls, accompanied by high, cold winds. These are severe on unprotected stock. The temperature rises rapidly during the spring months. Summer has a mean of 74° F. Over 100° F. has been recorded in July, August, and September. The hot season of the year is from the middle of June to the 1st of September. Usually there is a fresh breeze blowing in the summer, making the heat less

oppressive than the figures would indicate, and the comparatively low humidity in this section of the United States lessens the effects, but during the first part of September damage is occasionally done to growing crops by hot winds.

The average date of the first killing frost in the fall is October 17 and of the last in the spring April 26. The average growing season is thus 170 days. The date of the earliest recorded killing frost in the fall is September 18 and of the latest in spring May 19.

The average velocity of the wind, as recorded at Omaha, Nebr., is slightly over 9 miles per hour, and this varies with the season. In March and April it reaches 12 miles per hour. Velocities of 30 to 40 miles are not uncommon and 50 to 80 miles per hour has been recorded almost every year during storms. Pottawattamie County, like all the mid-continental region, is subject to an occasional tornado, but they are very rare and usually affect small areas.

The following table, compiled from the records of the Weather Bureau station at Omaha, Nebr., just across the river from Council Bluffs, gives normal monthly, seasonal, and annual temperature and precipitation data applicable to Pottawattamie County:

*Normal monthly, seasonal, and annual temperature and precipitation at Omaha, Nebr.*

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.*	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December.....	27	71	-17	1.0	0.9	0.7	5.4
January.....	21	63	-32	0.6	0.5	1.0	5.0
February.....	25	78	-26	0.7	1.3	1.1	5.0
Winter.....	24			2.3	2.7	2.8	15.4
March.....	36	85	- 7	1.4	0.9	0.5	5.3
April.....	52	92	6	3.0	2.3	3.2	0.2
May.....	62	97	28	4.4	0.6	11.3	0.0
Spring.....	50			8.8	3.8	15.0	5.5
June.....	72	100	42	5.2	4.7	12.7	0.0
July.....	76	106	50	4.6	0.6	4.8	0.0
August.....	74	105	44	3.5	0.4	3.4	0.0
Summer.....	74			13.3	5.7	20.9	0.0
September.....	66	102	30	2.9	2.5	4.5	0.0
October.....	54	92	15	2.5	2.9	5.0	0.6
November.....	38	80	-14	1.0	0.1	0.6	2.4
Fall.....	53			6.4	5.5	10.1	3.0
Year.....	50	106	-32	30.8	17.7	48.8	23. <sup>c</sup>

## AGRICULTURE.

Lewis and Clark, explorers, were the first white men to traverse the territory that is now known as Pottawattamie County, they having passed along the Missouri River in 1804. Twenty years later Hart, a French fur trader, established a fur-trading post on the present site of Council Bluffs, and a few years later the American Fur Company established another post in the same vicinity.

Prior to 1838 there was practically no agriculture carried on in the county, the few whites in this section being fur traders. In that year the Government sent a man by the name of Hardin to Pottawattamie County to teach the Indians there how to till the soil. Corn, wheat, and oats were the principal crops grown, with some vegetables. By this time there were a good many settlers in this region, and in 1839 two companies of troops were stationed in the eastern part of Council Bluffs to protect the settlers from the Indians. In 1846-47 the Pottawattamie Indians were removed to Kansas. In 1847 a party of Mormons settled near Millers Hollow, later called Kaneshville, now a part of the city of Council Bluffs. The Mormons grew enough wheat, oats, corn, and vegetables for their own consumption, but owing to the lack of transportation facilities they made no attempt to cultivate large areas. In 1852 they sold their lands and moved west.

In 1853 a railroad survey was made and in 1856 a railroad was in operation in the county. Two years later the Mississippi & Missouri Railroad (now the Chicago, Rock Island & Pacific) built a line through the county. With the advent of the railroads agriculture was extended. Corn, oats, spring wheat, and barley were the principal crops grown. During the period from 1860 to 1880 considerable sorghum was produced, thousands of barrels of sirup being shipped from Council Bluffs.

Stock raising became an important branch of agriculture at an early date. In 1864 over 20,000 hogs were butchered in the county, and by 1865 Council Bluffs was considered the greatest stock market in the State.

The bluff lands along the Missouri River bottoms were early recognized as peculiarly adapted to the production of grapes and apples, and by 1870 hundreds of acres were planted to these fruits.

In 1880, according to the census, Pottawattamie County had a population of 39,850. The total number of farms in operation at that time was 3,254, of an average size of 126 acres. Corn, oats, wheat, rye, barley, buckwheat, flaxseed, hay, potatoes, and sorghum were the principal crops grown. Corn led in acreage, 157,334 acres being planted, from which 7,350,176 bushels were produced; wheat was second, with 59,073 acres sowed and 699,324 bushels produced;



oats was third, 370,788 bushels being produced from 11,293 acres. By 1890 the population had increased to 47,430, and the number of farms to 3,765. The size of farms had also increased to 145 acres. Of the farms in the county, 66.22 per cent were operated by owners and 33.78 per cent by tenants. Corn was still the principal crop, 214,595 acres being planted, producing 9,790,327 bushels. Oats came second, with 37,214 acres sowed and a production of 1,142,805 bushels, and barley third, with 22,531 acres, which produced 597,289 bushels. Wheat dropped to fourth place, with only 6,650 acres sowed and a production of 76,710 bushels. The value of market-garden products, including small fruits sold, was \$59,574.

According to the census of 1900, the population of the county was 54,336, showing an increase of 6,906 in 10 years. There were 4,239 farms, 55.4 per cent of which were operated by owners, 44.1 per cent by tenants, and 0.5 per cent by managers. The average size of farms was 138.5 acres, and the average price of farm land was \$41.27 per acre. Corn was the leading crop, with 230,564 acres planted and 9,914,660 bushels produced; wheat was second, with 65,174 acres sowed and a production of 919,180 bushels; and oats third, with 36,936 acres sowed and 1,113,300 bushels produced. Rye, barley, buckwheat, alfalfa, clover, wild and tame grasses, potatoes, apples, grapes, berries, and vegetables were the other crops of importance at this time.

The census of 1910 shows a decrease of 304 in the total number of farms and an increase of 7.5 acres in the average size of farms. The average value of each farm was estimated at \$19,086, the land being worth \$99.88 per acre. At this time 54 per cent of the farms were operated by owners, 45.2 per cent by tenants, and 0.8 per cent by managers. The population of the county was 55,832, showing a gain of 1,496 in 10 years. Corn, oats, and wheat were the leading crops, in the order named, 8,535,650 bushels of corn being produced from 211,870 acres, 989,763 bushels of oats from 42,592 acres, and 319,578 bushels of wheat from 24,705 acres. Barley, rye, timothy, alfalfa, clover, millet, potatoes, vegetables, apples, grapes, and small fruits were also extensively grown. Cattle raising had also become an important industry, 3,670 calves, 41,435 other cattle, 114,312 swine, and 12,534 sheep and goats being sold or slaughtered in 1909.

In 1912,<sup>1</sup> 194,288 acres, or 32 per cent of the total acreage of the county, were devoted to corn, 7,351,165 bushels, or an average of 37 bushels per acre, being produced. At 36 cents per bushel, the value of the corn crop that year was \$2,646,419.40.

Corn is successfully grown on all the soil types of the county. It does particularly well on the Marshall silt loam, and yields of 80

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<sup>1</sup> Figures for 1912 taken from the Iowa Yearbook of Agriculture.

bushels per acre are not uncommon. During favorable years good crops of corn are also grown on the terrace and bottom lands, although these are not considered quite as good corn land as the higher Marshall silt loam.

Corn is planted after almost any crop. A common practice is to plant it after clover or clover and timothy. The hay land is usually plowed in the fall and thoroughly worked in the spring with disk and harrow. The corn is put in either with a planter or lister. When the planter is used the seed is either drilled in rows or planted in hills. The lister plants the corn in addition to preparing the seed bed. Listed corn is planted in rows and in a furrow. On listed corn a two-row cultivator popularly known as the "go-devil" is used.

As a rule the corn receives three or four cultivations, single-row cultivators of both the riding and walking types being used. Planting is done from May 1 to May 20, and the corn is usually "laid by" by the middle of July. Most of the corn is husked by hand in the field, though some is usually cut for fodder. A small quantity is cut while still green for ensilage. When corn is to be planted on corn-stalk ground the stalks are cut up with a stalk cutter or disk, and the ground is then thoroughly disked, no further preparation of the seed bed being made.

Oats rank next to corn in acreage and production. In 1912, 45,572 acres were devoted to this crop, and 1,378,985 bushels, or about 30 bushels per acre, were produced. The value of the crop was approximately \$372,325.95. In 1913,<sup>1</sup> 47,044 acres were sowed, producing 1,680,395 bushels, or an average yield of 36 bushels per acre. The oats are nearly all fed on the farms where they are grown.

Wheat is one of the main money crops of the county. Formerly only spring wheat was grown, a general impression prevailing that winter wheat could not be grown in Iowa on account of the light snow and the severity of the winter. Winter wheat, however, succeeds as far north as Canada. It is not as deep a feeder as oats, but makes ready use of plant food near the surface which usually is leached away and lost. Winter wheat does best in a fairly loamy soil and one rich in humus. It grows successfully, however, on heavy clay lands and matures grain of very good quality. Winter wheat fits well into Iowa rotations. Corn can be grown two years in succession, followed by oats, and then winter wheat and clover can be successfully seeded by broadcasting the clover on the wheat in February or March whenever there is a light fall of snow. Winter wheat is an excellent nurse crop on account of the small amount of leafage, which insures against too much shading of the ground and promotes early maturity. In 1912 there were 27,145 acres in winter wheat, producing an average

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<sup>1</sup> See Iowa Yearbook of Agriculture, 1913.

yield of 22 bushels per acre, and 15,947 acres in spring wheat, producing an average yield of 15 bushels per acre. Because of the larger yields of winter wheat it is rapidly growing in favor. Another advantage lies in the fact that it can be sowed when farm work is slack.

Barley is not as extensively grown now as formerly. In 1912, 3,661 acres were sown to this crop, with a total production of 102,920 bushels.

There were 8,531 acres, or 1.41 per cent of the total acreage of the county, devoted to alfalfa in 1912, from which 17,476 tons were produced. Monona County, which lies in the second tier of counties north of Pottawattamie, in the Missouri loess area, is the only county in the State which produces more alfalfa than Pottawattamie County. The Missouri loess area, according to Bulletin No. 137 of the Iowa Agricultural Experiment Station, is the best section of the State for the growth of alfalfa. Data from the above bulletin show that 71.1 per cent of the seedings in this area are successful. According to the Iowa Yearbook of Agriculture for 1913, 14,588 acres were devoted to alfalfa in that year, from which 33,572 tons, or an average of 2.3 tons per acre, were produced. Three or four cuttings per season are usually obtained. Where four cuttings are obtained yields of 7 tons per acre are occasionally recorded. Alfalfa thrives in every part of the county, except on the lower overflowed bottoms, and even there it does fairly well during dry seasons. Owing to the high lime content of the soils of the county, it is not necessary to lime the soil before sowing alfalfa.

Timothy and clover are also important hay crops, to which 34,356 acres were devoted in 1912, with an average yield of 1 ton per acre.

Melilotus, or sweet clover, does well on the soils of the county and grows wild along roadsides and ditch banks. This legume is regarded as undesirable by the farmers of Pottawattamie County and it is not encouraged. This plant is recognized in some sections of the South as one of the most valuable for forage. The Iowa Agricultural Experiment Station is beginning to direct attention to this plant.

Irish potatoes do well on the mellow silt loam soils occurring throughout the county. In 1912, 2,407 acres of potatoes were grown, with a total production of 153,823 bushels, worth—at 44 cents per bushel, the farm value on December 1 of that year—approximately \$67,682. During the year 1913, 2,316 acres were planted, with a production of 118,797 bushels, the value of which, at the farm value of 85 cents per bushel, was about \$100,977. Sweet potatoes do well on the sandy bottom types.

The grape industry of the county is constantly increasing in importance. During the season of 1914 between 550 and 600 acres were



planted to grapes and 90 carloads of fruit were shipped from Council Bluffs to outside markets. The grape growers have an effective co-operative buying and selling association, with a membership numbering between 100 and 150, which controls at least 500 acres of the grape plantings. The average number of 8-pound baskets handled annually during the last 11 years is 181,000, and these were sold at an average price of 18½ cents per basket. During that period the average annual business of the association amounted to \$72,365. Some of the best growers realize an annual net profit of \$100 per acre. As a whole the vineyards are poorly managed, cultivation is neglected, the soil is allowed to wash, pruning is done in a haphazard way, and little effort is made to combat fungous diseases and insect pests. Pruning experiments have been started with the growers, however, and plans are under way to take up a study of the grape-root worm and the leaf hopper, which endanger the grape industry of this section. The grape does particularly well on the Knox silt loam. A considerable amount of the steep bluff land in the vicinity of Council Bluffs which is unsuitable for the production of field crops has recently been planted to vineyards.

In 1913 there were 3,246 acres in orchards, from which 24,146 bushels were harvested. In 1914, with proper pruning and spraying, the agricultural experiment station near Council Bluffs produced over 4,000 bushels of apples from 15 acres of trees. Some of the principal varieties grown are the Ben Davis, Roman Stem, Grimes Golden, Gano, Jonathan, Winesap, Mammoth Black Twig, and Northwestern Greening.

Nearly every farm has 5 to 25 cherry trees, and several carloads of this fruit were shipped from the county in 1914. Both the early and late varieties are grown, and the production of this fruit is being gradually extended.

Land which ordinarily sells for \$100 or less an acre brings as much as \$300 an acre when planted to orchard crops.

Owing to its many excellent bluegrass pastures and its splendid market facilities, Pottawattamie County is one of the leading stock-raising counties of the State. The Iowa Yearbook of Agriculture for 1912 reports 21,815 horses, 2,104 mules, 170,708 hogs, 49,459 head of cattle, and 22,509 sheep in the county. The horses are nearly all of the draft type, weighing 1,200 to 1,600 pounds, all of the principal draft breeds being well represented. Of the cattle, 13,578 are classed as dairy cows and heifers kept for milk. Most of the cattle are Shorthorn, although there are also many herds of Angus and Hereford. Nearly every standard breed of hogs is represented in the county, Duroc Jersey, Chester White, and Poland China being the most popular.

In 1912 there were 3,106 farms in the county, their average size being 166 acres. Of the total farm acreage of 514,593 acres, 130,353 acres were occupied by pasture, 28,094 acres by buildings, public highways, and feed lots, 3,359 acres by orchards, and 953 acres by gardens.

Land ranges in value from \$65 to \$300 an acre. Land along the Missouri River subject to overflow, which is considered the least valuable land in the county, sells for \$65 to \$100 an acre. This land is all level and much of it is easy to work. During seasons when there are no overflows very good crops of corn, hay, and small grains are produced upon it. In this section the farm buildings are poor, compared with those where the land is not subject to overflow. The eastern three-fourths of the county is the most desirable from an agricultural point of view and the land sells for \$125 to \$250 an acre. Nearly all of this land is gently rolling to hilly.

Nearly every farm is well equipped with buildings. The houses are large, often with modern conveniences, many farmers having their own light and water systems. The yards are all well kept, and the barns are built with a view to housing the stock in the severest winter weather. Nearly every large farmer owns an automobile. In 1910 the estimated average value of farm buildings was approximately \$2,000 per farm. The county is well covered with rural mail delivery routes. A considerable number of grain elevators are located throughout the county, and the farmers have no difficulty in disposing of their small grain and corn at near-by markets. There are two flour mills, one located at Walnut and the other at Council Bluffs.

Labor is not easy to obtain. Most of the hired help comes from Missouri and the counties in Iowa south of Pottawattamie. The laborers are quite efficient, and, as a rule, good wages are paid. In 1912 the average monthly wage for farm hands during the summer months was \$30.29, besides board, room, and washing. During the harvest season day wages reached \$3, with board. Winter wages averaged \$23.32, with board, room, and laundry. Wherever possible, four-horse teams are used, and as little manual labor is employed as possible.

#### SOILS.

The soils of Pottawattamie County are much alike in both color and texture. They are generally dark in color and silt loams in texture. They may be divided on the basis of origin and physiographic position into three well-defined groups—wind-blown or loessial soils, recent stream alluvium or frequently overflowed first-bottom soils, and old stream alluvium or second-bottom soils lying above normal overflow.

Within the broader divisions the soils are separated into series and types, the latter distinction being based on texture.

The uplands, representing the wind-blown or loessial material, comprise the Marshall and Knox series, the recent stream-alluvium or first-bottom soils the Sarpy and Wabash series, and the terrace soils, representing old alluvium, the Osgood and Hancock series.

The upland soils are all derived from the weathering of the loess that mantles the uplands and varies in depth from 10 to 150 feet. The Knox and Marshall silt loams are developed here.

The Knox series, including only the silt loam type, occurs as a belt running the entire length of the county and bordering the lowlands of the Missouri River. It varies in width from three-quarters of a mile to  $3\frac{1}{2}$  miles. This belt of soil is characterized by steep bluffs and generally rough topography.

Of the Marshall series only the silt loam occurs. It is the most extensive soil in the county. It has a dark-brown to black color in the surface soil and a yellowish-brown color in the subsoil, and is formed from the weathering of the Missouri loess.

The Hancock and Osgood soils, lying along the Missouri River and some of the other larger stream courses in the county, occupy positions sufficiently elevated to be above normal overflow. These types contain a good deal of loess material, as well as old alluvium and glacial drift brought down by the streams when flowing at a higher level than at present.

The Wabash and Sarpy series are developed in the flood plain of the Missouri River, East and West Nishnabotna Rivers, and other drainage ways. The strips occupied by this soil vary in width from one-eighth of a mile to 6 miles.

Pottawattamie County lies outside of the limits reached by the Wisconsin and Iowan drift sheets. While these drift sheets were being laid down farther north and east this region was subjected to the work mainly of destructive forces, acting on the glacial deposits of the Kansan stage. The bedrock of the county is deeply buried under old glacial drift and consists mainly of soft shales that lie in an almost horizontal position.

In the northeast corner of the county bedrock appears at 980 feet above sea level and in the southeast corner it rises a hundred feet higher.

A few exposures of bluish-gray clay appear along the west bank of the East Nishnabotna River and along the slopes of quite a number of the smaller streams throughout the county. These bluish-gray clays belong to the Cretaceous period. Owing to their small extent they have not to any great extent influenced the formation of the soils.

Six distinct soil series, represented by nine types, are mapped in Pottawattamie County. The following table gives the names and extent of the several soil types found in the county:

*Areas of different soils.*

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Marshall silt loam.....	416,768	68.0	Sarpy very fine sandy loam..	11,008	1.8
Wabash silt loam.....	37,184	13.4	Hancock silty clay.....	3,520	.6
Colluvial phase.....	44,864		Sarpy very fine sand.....	2,496	.4
Wabash silty clay.....	51,520	8.4	Osgood very fine sand.....	384	.1
Knox silt loam.....	28,992	4.7			
Hancock silt loam.....	15,744	2.6	Total.....	612,480	.....

MARSHALL SERIES.

The Marshall series includes the dark-colored upland loessial soils covering wide areas in the prairie region of the Central West. The surface soils are dark brown to black and the subsoil somewhat lighter. The topography is level to rolling and hilly. In Pottawattamie County this series includes the silt loam type only.

MARSHALL SILT LOAM.

The surface soil of the Marshall silt loam is a dark-brown to black silt loam, ranging in depth from 10 to 24 inches and averaging about 20 inches. When wet this soil presents a solid black appearance, but when thoroughly dry shades of dark brown can be seen. Near the line of division between the soil and subsoil the color becomes lighter and sometimes a faint mottling of yellow, gray, or drab is encountered. The mottling depends to some degree upon the completeness of the subsoil drainage. The subsoil is a yellow silt loam extending to a depth of 10 to 20 feet in the more shallow deposits and to 20 to 80 feet and even more where the deposits are fully developed. Where covered with timber the type presents a lighter appearance than on the open prairie. Both the soil and subsoil are free from gravel or sandy material, except in a few places at the base of high hills, where outcroppings of gravel or glacial till are encountered. Lime concretions varying from one-half inch to 6 inches in diameter and accumulations of soft lime carbonate are common in the subsoil, and occasionally the remains of shells, principally snails, belonging to the land form of organic life, occur.

The Marshall silt loam is extensively developed in southwestern Iowa and covers 68 per cent of the total area of Pottawattamie County.

The topography is nearly level to undulating, rolling, or hilly. The type occupies an elevation throughout the county ranging from

1,000 to 1,200 feet above sea level. In the western part of the county the Marshall and Knox silt loams grade into each other, the Knox being somewhat lighter in color and in many cases occupying a higher elevation than the Marshall. The natural drainage of this type is thorough. Many of the streams have cut deep channels through the type and in a few instances some of the hill slopes leading to these drainage ways have been badly eroded.

The Marshall silt loam has a high content of organic matter and an excellent moisture-holding capacity. Where given the proper attention crops seldom suffer from lack of moisture. About 90 per cent of this type is under cultivation, scarcely any of it being waste land. All the general farm crops grown in this section do well on it and little attention has been given to special crops. Corn, oats, and wheat are the principal crops grown. The average yield of corn on all the soil types of the county is 39 bushels per acre, but on the Marshall silt loam it ranges from 40 to 45 bushels and in many places where special attention is given the crop 75 bushels per acre are obtained. Wheat yields 24 to 30 bushels per acre. Little or no trouble is experienced from lodging.

Legumes such as alfalfa, red clover, and melilotus, or sweet clover, do exceptionally well on this type. Three or four cuttings of alfalfa, yielding three-fourths ton to 1 $\frac{1}{4}$  tons each, are obtained during the year.

A large number of vegetables, including tomatoes, potatoes, beans, cabbage, eggplant, beets, turnips, and parsnips, do well, although grown only for home consumption as a rule.

From the results obtained on small experimental vineyards, grapes will apparently give better yields on this type than on the Knox silt loam, to the rough broken areas of which viticulture has heretofore been confined.

The Marshall silt loam is an excellent soil for the production of apples and the Iowa Agricultural Experiment Station orchard is located upon it.

Where proper attention is given to the matter of crop rotations on this type yields are increased 10 to 25 per cent. The most common rotation practiced on this land consists of corn for two or three years, followed by winter wheat or oats, and then timothy, clover, or alfalfa for two or three years.

Land of this type sells for \$125 to \$300 an acre, depending upon its location.

#### KNOX SERIES.

The Knox series includes light-brown soils derived from loessial or other wind-blown deposits. The subsoil, as well as the soil, is derived from loess and is somewhat lighter colored. The topography



is rolling to hilly and rough and the drainage is well established. This is one of the important grain-growing group of soils of the central prairie States. In Pottawattamie County the Knox series is represented by the silt loam type.

#### KNOX SILT LOAM.

The Knox silt loam is a light-brown silt loam which at a depth of 15 to 20 inches grades into a yellowish-brown to buff-colored silt loam. The line of division between the soil and subsoil is not marked by any sharp change of color or texture, there being a grading off from the brown color of the soil to the yellowish color of the subsoil. In places where vegetable matter has been allowed to accumulate the surface soil is somewhat darker, resembling very much the Marshall silt loam, but where the erosive elements have washed and leached away the organic matter a light or pale-yellow color is evident. Only a small quantity of clayey or sandy material is encountered within the 3-foot soil section, the texture remaining practically a silt loam to a depth of 10 to 50 feet. Both soil and subsoil are normally stone-free and very little sand is found in any except local areas where it has been washed from other soils. A few sand beds are found at the base of the high bluffs, but as these are 40 to 80 feet below the surface of the type they are of little effect from an agricultural point of view. The type differs from the Marshall silt loam in its lighter color and rougher topography.

The Knox silt loam occurs as a narrow strip 24 miles long and ranging from 1 to 5 miles in width, bordering the lowlands of the Missouri River, and is characterized by steep bluffs and a generally rough topography. These bluffs rise 100 to 150 feet above the level of the lowlands and have an elevation of 1,100 to 1,300 feet above sea level.

The drainage of this type is generally good. In a few places, where there are steep, unprotected slopes, it is excessive. Numerous drainage ways or gulches occur throughout the bluff section. Some of the slopes leading to the stream channels are so steep as to prohibit cultivation. Many of the bluffs present a terrace or steplike appearance called "cat steps," caused by faulting or settling of the silty material. Very little vegetation of any kind grows near the top of these bluffs, but on the lower slopes, where a deeper soil has been formed, various grasses, trees, and crops thrive. A number of areas of this type that had been cultivated for several years to intertilled crops have had to be abandoned owing to the severe erosion.

One of the best uses of these steep slopes is for the cultivation of grapes, and their utilization for this purpose is being extended. There are many large vineyards on the Knox silt loam in the neigh-

borhood of Council Bluffs, and 95 per cent of the land in the county devoted to the production of grapes in 1914 consisted of this type.

On the lower, more level slopes of the bluffs corn, wheat, oats, alfalfa, timothy, clover, and a variety of vegetables, including potatoes, cabbage, tomatoes, and green peas, do well. Potatoes have given excellent yields on the small areas where planted. Where proper care is given the trees, apples, plums, and cherries do well on this type.

Owing principally to its deficiency in organic matter, the Knox silt loam is not as productive as the Marshall silt loam. Crops planted on this type are better suited to stand excessive rainfall than droughty conditions. This is due to the rough topography rather than to the texture or structure of the soil.

The two most important factors to be considered in the management of this type are the practice of crop rotations and the prevention of erosion. One rotation that has proved satisfactory includes corn for one or two years, followed by oats, wheat, clover, or clover and timothy, in the order named, each for one year. Under this system corn yields 35 to 75 bushels, oats 20 to 30 bushels, wheat 20 to 35 bushels, and clover and timothy hay 1 ton to 2 tons per acre. The soil contains considerable lime, and produces good yields of alfalfa. Where this legume is used in a rotation 4 to 6 years are generally allotted to its production before it is turned under. Alfalfa produces three-fourths ton to  $1\frac{1}{2}$  tons to the cutting, with 3 or 4 cuttings a year.

The Knox silt loam is divided into smaller tracts than the Marshall silt loam, farms ranging in size from 10 to 80 acres being common. The farmhouses are usually smaller in size, and as a whole the farms are less improved than those on the latter type.

The Knox silt loam ranges in price from \$100 to \$200 an acre, depending upon its topography, location, and improvements.

#### WABASH SERIES.

The Wabash series includes soils of dark-brown to black color and high organic-matter content, and slightly lighter drab or gray subsoils. The members of this series are developed typically in the first bottoms of streams of the Central Prairie States, the material being derived principally from the loessial and associated soils of this region. They extend for many miles along the Mississippi River. In this county the Wabash series includes the silty clay and silt loam types, the latter with a colluvial phase.

#### WABASH SILTY CLAY.

The surface soil of the Wabash silty clay is a dark-brown or black heavy silty clay loam having an average depth of 4 to 6 inches.

This is underlain by a heavy, stiff, sticky, plastic clay, bluish gray or drab to gray and brown mottled in color. The surface soil when wet becomes very slippery, and on drying cracks and separates into irregular cakes or blocks, forming crevices 2 to 6 inches in depth and 1 to 3 inches across. In areas where a small quantity of very fine sand is mixed with the clay the blocks formed on drying are much smaller, many having a round appearance and being called "buckshot." In places a stratum of very fine sand is encountered within the 3-foot section, lying between two layers of heavy clay. The type as a whole presents a very black appearance and is locally known as "gumbo."

The Wabash silty clay occupies level or depressed areas within the broader alluvial bottom lands, being typically developed along the first bottoms of the East and West Nishnabotna Rivers and the broad flood plain of the Missouri River. Typical areas are found along the Missouri River in the almost level tracts lying somewhat back from the main stream channel and usually somewhat above the level of the lowest depressions found in the bayous and hollows of the bottoms. It lies 5 to 15 feet above the normal level of the streams along which it occurs, and about 1,000 feet above sea level.

Although subject to overflow during high water, a considerable proportion of the type is well drained and admirably suited to agriculture. The lower depressions and old lake beds retain an excess of moisture until far into the summer and are not suited to cultivation. Much of the type has been well ditched, many deep canals having been constructed recently to carry off the surplus water coming from the uplands. Since the straightening and deepening of the Boyer and West Nishnabotna Rivers, and Willow, Pigeon, and Honey Creeks, large tracts of this type that were formerly allowed to stand idle owing to their wet condition have been put under cultivation.

The Wabash silty clay is not subject to erosion, except through changes in direction of the main stream channels. Quite a number of farms located along the Missouri River in the southern part of the county have been caused considerable loss by the shifting of the channel of the Missouri River.

Although the Wabash silty clay is very rich in plant food, few crops can be produced on it, owing to its location. Even areas which are thoroughly protected by levees along the principal streams are often covered during freshets with 6 inches to 2 feet of water, remaining in such condition long past the planting season. Very little tile draining has been done, and owing to the compact nature of the soil and subsoil, which necessitates the placing of tiles very close together, their use is very expensive.

Local drainage and seasonal precipitation are the two main factors determining the crop yields on this type. Corn is the principal crop grown, yielding 40 to 75 bushels to the acre. In many places corn has been grown 10 to 20 years in succession upon the same land without appreciable diminution in yield. Oats, spring wheat, and alfalfa also do well. Owing to the fertility of the soil, wheat grows very rank and often lodges, making it difficult to cut with the binder. Oats yield 20 to 35 bushels per acre and alfalfa 1 to 1½ tons per acre to the cutting, 3 or 4 cuttings being obtained in a season. Some of the lower and more poorly drained areas support a dense growth of bluegrass and slough grass. Bluegrass pastures are considered exceptionally valuable for the fattening of beef cattle, and many are used for that purpose. The slough grass, although rather coarse, is cut and used for hay.

In cultivating this type it is very important not to plow the land when too wet or too dry. If plowed when there is an excess of moisture present the soil forms into long, compact clods, which on drying it is almost impossible to work into a proper condition of tilth. On the other hand, if the surface soil is allowed to become too dry before plowing huge lumps are turned up and no harrowing or working is capable of crushing them into small enough particles to insure a good seed bed.

The forest growth on this type, consisting mainly of willow, is of little commercial value.

The price of land of the Wabash silty clay ranges from \$65 to \$125 an acre, depending on its protection from overflows, its elevation, and its location with respect to markets and railroads.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Wabash silty clay.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
330907.....	Soil.....	0.1	0.4	0.5	4.8	7.0	52.6	34.6
330908.....	Subsoil.....	.0	.2	.2	2.4	2.4	46.4	48.4

WABASH SILT LOAM.

The surface soil of the Wabash silt loam is a dark-brown to very dark brown mellow silt loam which becomes almost black in depressed areas. The depth of the surface soil varies considerably, depending upon the frequency of overflow and the amount of deposition during flood periods. Usually it ranges from 8 to 15 inches in depth and in

places reaches a depth of 25 inches. The subsoil is somewhat lighter in color than the surface soil, becoming still lighter in the lower portion. At a depth of 36 inches or more it is usually a light-brown or mottled yellow and gray heavy silt loam. In places pockets of very fine sand occur. Some of the small, poorly drained areas have a decidedly clayey texture and would be mapped as Wabash silty clay were it not for their small extent.

The Wabash silt loam is typically and extensively developed throughout the county, along the overflowed bottoms of Walnut Creek and Pigeon Creek. Areas of this type that have not been cleared still support a sparse timber growth, including walnut, willow, box elder, ash, and cottonwood.

The topography of the Wabash silt loam is almost level. The type occupies first bottoms and is subject to annual overflows. In places a bench or terrace has been formed at the foot of slopes, and areas of this kind are usually better drained than the flat areas. Considerable areas of this type have been materially benefited by the straightening and deepening of the main channels along Pigeon and Keg Creeks. The type is subject to severe erosion along bends and meanders. Frequently the streams cut into the soft silty lands on the outward edges of the bends, removing many acres of fertile soil and depositing it at other points. Brush dams will check this erosion somewhat, but the straightening of the channels by dredging is the only sure way to protect the land. Occasionally after very heavy rains crops along the main channel are injured or destroyed by some of the small tributaries with steep grades descending from the uplands at flood stage and depositing large quantities of locally gained material on them.

The Wabash silt loam is considered one of the most fertile types in the county, but its crop adaptation is somewhat narrow, owing to its liability to floods and to the high water table. Along some of the streams where the channels have been allowed to fill up with sediment and brush the water table is only 3 or 4 feet below the surface.

Corn is the most important crop grown on this type. Oats, grasses, and other general farm crops that can be planted and harvested the same season are also successfully grown. Winter wheat or long-season crops are liable to injury from drowning out during the winter months or from the heaving of the land under the action of the winter freezes. Corn yields 40 to 75 bushels per acre and may be planted year after year without any evidence of diminished yields. Occasionally the entire crop is drowned out, but if the seasons are favorable for three out of five years the yields are high enough to make farming profitable. Much of this type is seeded to grass and



used for pasturage. It is an excellent grass soil, and well adapted to live-stock raising. Alfalfa can be successfully grown, provided the stream channels are straightened and the water level lowered to at least 5 feet below the surface.

Land of this type sells for \$100 to \$150 an acre, depending upon its drainage and location.

*Wabash silt loam, colluvial phase.*—The Wabash silt loam, colluvial phase, occurs throughout the county as a narrow strip of alluvial and colluvial material bordering the minor streams or drainage ways. As the colluvial material seems to predominate, the soil has been indicated on the map as a colluvial phase of the Wabash silt loam. The color of the soil is almost identical with that of the typical soil.

Owing to the prevailingly steep slopes throughout Pottawattamie County, narrow belts of colluvial material have been deposited on the outer edge of the lowlands along nearly all the larger streams. These areas are in many cases too narrow to be shown on a map of the scale used. Many of these colluvial deposits are inundated during periods of heavy rainfall, but owing to the steep slopes and heavy grades the surplus water runs off very quickly.

The colluvial phase as a whole is fairly well drained. Very little trouble is caused by seepage, and that can be remedied by digging open ditches or placing a line of tile at the base of the slopes.

Nearly all of the crops grown throughout the county do well on this phase. Corn ranks first in acreage and production. Wheat, oats, rye, barley, alfalfa, timothy, clover, and small truck crops are also extensively grown. Oats and spring wheat do not as a rule do so well on this phase as upon the upland soils, being more subject to lodging and fungus diseases. Much of the colluvial phase that lies entirely above overflow is seeded to alfalfa, red clover, and rape, all of which do well. Corn yields 35 to 75 bushels, wheat 20 to 35 bushels, clover and timothy 1 to 2 tons, and oats 20 to 30 bushels per acre. The low-lying portion of the phase is in many cases allowed to grow up to native grasses and is used for pasture land. The phase is well adapted to cattle and hog raising. Along many of the small drainage ways water stands in holes the greater part of the dry season, and these are very often used as the main source of water supply for the live stock. A large number of rape fields on which hogs are successfully pastured are seen on this phase throughout the county.

Owing to the varying conditions as to overflow, drainage, and location, the value of land of this phase ranges widely, from \$75 to \$150, and even more, an acre.

## OSGOOD SERIES.

The soils of the Osgood series are light brown to brown and range in depth from 12 to 18 inches. The subsoils consist of grayish-yellow, friable fine sandy loam of silty texture. The series occupies low second terraces in stream valleys. The topography is nearly level, but the soils are not subject to overflow and are usually well drained. They are generally free from alkali salts. The material is of alluvial origin and derived from near-by loessial soils. In Pottawattamie County the Osgood very fine sand type is mapped.

## OSGOOD VERY FINE SAND.

The Osgood very fine sand consists of a brownish-gray to brown very fine sand, 12 to 15 inches deep. The subsoil is composed of a grayish to light-brown very fine sand, the light color being in evidence throughout the 3-foot section.

This type is found associated with the Sarpy and Wabash soils, but it occupies a higher elevation and is not submerged during periods of high water. It has a somewhat billowy surface and owing to this and its loose, incoherent structure it is rather a well-drained soil.

The Osgood very fine sand is inextensive. It is mapped in four small areas near the Missouri River, west and south of Council Bluffs.

Owing to the droughty nature of this sandy type crops are likely to suffer from lack of moisture during dry seasons. This, together with the low content of organic matter, makes the Osgood very fine sand less valuable than any of the heavier soils of the bottom lands. Only one area of this type was in cultivation at the time of the survey. A part of it was in alfalfa, which was not doing well, and a part was in corn, which was about as good as that found on the heavier soils. Sandbur and a few native grasses constitute the principal natural growth on this land. Where well fertilized with barnyard manure, the type can be profitably utilized for early truck crops, melons, and cantaloupes.

## HANCOCK SERIES.

The soils of the Hancock series range in color from dark brown to black and the subsoils from yellowish brown and gray mottled to gray and brown mottled or drab. The subsoils are of about the same texture as or may be heavier than the soils. The different members of the series are distinctly calcareous, particularly in the subsoil. They are alluvial in origin, occupying flat and gently sloping high bottoms above overflow and terraces at somewhat higher level. Colluvial areas of level or gently sloping topography where the material is essentially identical with that of the strictly alluvial areas also occur. The natural drainage is only fair to deficient. The series is developed throughout the loessial belt of the Central West, principally in association with the Marshall and Knox upland soils.

These soils are very productive. In Pottawattamie County the silt loam and silty clay types are mapped.

#### HANCOCK SILT LOAM.

The soil of the Hancock silt loam to a depth of 12 to 15 inches consists of a brownish-black silt loam. The subsoil becomes lighter in color with depth, grading from chocolate brown to mottled yellowish brown and gray, and ranging in texture from a silt loam to a silty clay loam. In many places strata of very fine sandy material are intermingled with the typical silt loam.

The Hancock silt loam is a second-bottom or terrace soil bordering the overflowed bottoms of some of the main drainage ways of the county. It is rather extensively developed at and south of Council Bluffs and bordering the overflowed bottoms of the East and West Nishnabotna Rivers and creeks.

The type has an almost level surface, sloping gently toward the streams which it borders. It is fairly well drained as a whole, but the water stands in some of the level areas and depressions after hard rains, and these areas require artificial drainage.

The Hancock silt loam, like the Hancock silty clay, was undoubtedly at one time subject to overflow. The type may be considered of both alluvial and colluvial formation, large quantities of soil material being washed down upon the benchlike formation from the adjacent slopes after each heavy rainfall.

Owing to its elevation this type is not subject to overflow, and for this reason, together with the high content of organic matter, it is considered one of the most valuable lowland types in the county.

Practically all of this type is cleared, and about 90 per cent of it is in cultivation, the remainder being used for pasture. Corn leads all other crops both in acreage and production, and yields 40 to 80 bushels per acre. Wheat ranks second, with a yield of 20 to 40 bushels per acre. Alfalfa, clover, timothy, rape, and various truck crops, such as cabbage, tomatoes, squash, peppers, beans, and potatoes, do exceptionally well on this type.

The Hancock silt loam sells for \$100 to \$200 an acre, depending largely on its location.

In the following table mechanical analyses of samples of the soil and subsoil of this type are given:

*Mechanical analyses of Hancock silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
330911.....	Soil.....	0.0	0.1	0.1	3.0	16.9	65.4	14.7
330912.....	Subsoil.....	.0	.0	.1	1.6	6.3	71.0	21.0

## HANCOCK SILTY CLAY.

The Hancock silty clay is a black silty clay ranging from 4 to 6 inches in depth. Beneath this a dark-brown to black clay is encountered, which extends to a depth of 12 to 15 inches, giving way below to a gray and brown mottled or drab heavy plastic clay, which extends to a depth of 3 feet or more.

Although now occupying a terrace position, this type shows many indications of having been at one time overflowed.

The topography is practically level, perhaps gently sloping toward the lower areas along the river. Underdrainage is fairly well established, but owing to the flat surface of the type the run-off is not sufficient in all cases and water stands in the small depressions. The soil when saturated becomes very slippery and muddy.

The Hancock silty clay is not extensively developed in Pottawatamie County. The main body of it is located between Council Bluffs and Manawa Lake. The south residence portion of Council Bluffs is built to a large extent on this type.

The Hancock silty clay is an excellent agricultural soil. It contains a high percentage of organic matter, and owing to the fact that it lies above normal overflow there is little danger of loss of crops by floods.

Corn, alfalfa, clover, and various truck crops give good yields. Corn yields 40 to 75 bushels to the acre, and alfalfa gives 1 ton to 1½ tons to the cutting, with 3 or 4 cuttings a year. Where alfalfa is sowed the soil should be well drained, either by open ditches or tile drains. Truck crops, such as beets, tomatoes, cabbage, Irish potatoes, and beans, give good yields, but are rather late in maturing.

As in the case of the Wabash silty clay, it is almost impossible to work this soil into a good seed bed if it is plowed when too wet or too dry. On uncultivated areas native grasses thrive, affording excellent pasturage.

Owing to its location in and near the city of Council Bluffs the Hancock silty clay is very valuable, the price ranging from \$100 to \$500 an acre. The higher prices are the result of its value for building lots rather than for agriculture.

The results of mechanical analyses of samples of the soil and subsoil of this type follow:

*Mechanical analyses of Hancock silty clay.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
330905.....	Soil.....	0.0	0.1	0.2	2.4	8.9	54.8	33.7
330906.....	Subsoil.....	.0	.1	.2	4.0	8.6	49.2	38.0

## SARPY SERIES.

The types in the Sarpy series have light-brown to nearly black surface soils. The subsoils are brown to yellowish brown and distinctly lighter in texture than the surface soils. This series is of alluvial origin and occurs in the bottoms of the Mississippi and Missouri Rivers and their larger tributaries. In Pottawattamie County the series is represented by the very fine sand and very fine sandy loam types.

## SARPY VERY FINE SANDY LOAM.

The surface soil of the Sarpy very fine sandy loam is a light brownish gray or grayish-brown very fine sandy loam averaging 10 to 15 inches deep. The subsoil very much resembles the soil in color, but as a rule is more open in structure and coarser in texture. The percentage of sand increases with depth, in many cases the texture grading into a very fine sand at a depth of 36 inches or more. The type is deficient in organic matter. Included with this type are a number of spots of heavier material, varying in texture from silt loam to clay, which are too small to indicate on a map of the scale used. A 3-foot profile of this type would show a structure made up of alternate layers of various thickness and texture, each layer representing a period or stage of overflow.

The Sarpy very fine sandy loam is usually associated with the heavier, poorly drained Wabash silty clay, although it occupies a slightly higher elevation than the latter type, lying 10 to 15 feet above the main channel of the river. The topography is level to slightly undulating, with occasional sandy ridges, and the drainage is good. In many instances the type extends to the channel of the river, and in such places the banks cave badly, owing to the loose structure of the material, and frequently small areas are undermined and precipitated into the river. This type, like other soils occupying first-bottom positions, is generally subject to overflow. The floods usually come during the growing season and frequently destroy the crops.

Corn is the principal crop grown upon the Sarpy very fine sandy loam, and it produces 30 to 65 bushels per acre. Wheat, oats, timothy, clover, and alfalfa are grown to a small extent. Truck crops, such as sweet potatoes, Irish potatoes, cabbage, melons, and cantaloupes, are increasing in acreage. Alfalfa gives good yields, but is likely to be drowned out by flood waters. About 20 per cent of this type, generally areas occupying the lowest positions, supports a native growth of slough grass and other water-loving grasses, in addition to willow and cottonwood trees. The type can be profitably used as pasture land.

This type sells for \$65 to \$125 an acre, depending upon its liability to flood and its location with respect to markets, etc.



## SARPY VERY FINE SAND.

The Sarpy very fine sand is a light-brown to grayish-brown very fine sand to a depth of 10 to 15 inches. This grades into a slightly darker colored sand, the texture remaining the same throughout the 3-foot section.

There are a few small areas of sand bars or Riverwash included with this type, but owing to the similarity in both color and texture no separation was made.

The Sarpy very fine sand occurs as long, narrow ridges in old channels of the Missouri River and on the flood plains adjoining, where the current of the river was comparatively swift. Many of these deposits of very fine sand are constantly being shifted by changes in the river channel or by the wind, and within a very short period an area may be either doubled in size or removed entirely. Quite often on areas where "blow-outs" have occurred a vertical section may show a deposit of sand completely buried beneath 3 feet or more of clay, or vice versa.

The topography of these sand areas is level to gently undulating, although in a few places small dunes have been formed by the action of the wind. Owing to its loose, open structure the type is well drained.

The native vegetation consists of sandbur, willow, cottonwood, and various grasses.

The soil is not highly valued for agriculture, and comparatively little of it is cultivated. It has a very low content of organic matter, and crops suffer from lack of moisture during dry seasons. Corn, watermelons, and cantaloupes are the principal crops grown. Corn produces only fair yields, but melons flourish on this soil. The best use of the type is as pasture land.

## SUMMARY.

Pottawattamie County is situated in the southwestern part of Iowa adjoining the Missouri River and the State of Nebraska in the third tier of counties north of the Missouri State line. It contains a total area of 957 square miles, or 612,480 acres.

The topography of the upland varies from undulating to rolling and rough, while the heavily overflowed bottoms and terraces are practically level. The uplands range in elevation from 1,000 to 1,300 feet above sea level.

The county has a very extensive drainage system, being drained toward the southwest into the Missouri River, the main tributaries of which are the Boyer and East and West Nishnabotna Rivers. The slopes adjacent to the drainage ways are smooth and, as a rule, easily cultivated, and the alluvial bottoms are wide and very fertile.

The climate of Pottawattamie County is very healthful. The mean annual temperature is 50° F. and the mean annual precipitation 30.8 inches. The rainfall is well distributed throughout the growing season, and crops seldom suffer from drought.

The county is well settled. The average size of land holdings ranges from 160 to 200 acres. Land values are high, ranging from \$75 to \$300 an acre.

The county has excellent transportation facilities, being served by nine railroad lines. The public roads of the county are in good condition. The county is crossed by two State highways and one trans-continental highway.

The type of agriculture usually followed in the county consists of general farming combined with live-stock raising. Corn, wheat, barley, rye, oats, timothy, alfalfa, and wild hay are the principal crops, named in the order of their importance. Truck crops, apples, grapes, and other small fruits are extensively grown for home consumption. The farms are usually well improved, and good farming methods are followed.

Systematic crop rotation is practiced to a small extent. About 54 per cent of the farms are operated by owners, 45.2 by tenants, and 0.8 by managers.

The soils of the county are rather uniform, both in texture and in method of formation. Six series, comprising 9 types, are mapped, ranging from very fine sand to clay in texture. In origin they may be classed as sedimentary, eolian, colluvial, and alluvial.

The Marshall silt loam is the most extensive type. It is a black silt loam, extremely valuable as an agricultural soil, and occupying gently rolling to rolling and hilly topography. Corn, wheat, rye, barley, alfalfa, clover, and timothy are extensively grown on this type.

The Knox silt loam is developed in the bluff section of the county. This type, where not of rough topography, is an excellent soil for corn, wheat, alfalfa, and orchard crops. Grapes do especially well on it.

The Wabash silty clay is the dominant soil of the alluvial group. It occupies a first-bottom position, is subject to frequent overflows, and is conspicuous on account of its black color. The type is well adapted to corn, but is hard to cultivate.

The Wabash silt loam is a first-bottom soil occurring along the medium-sized streams. It is well supplied with vegetable matter and is very productive. Crops are more or less uncertain on account of the liability to overflows.

The Wabash silt loam, colluvial phase, occupies areas adjacent to the small drainage ways of the county. The soil is both alluvial and colluvial, being formed by washing of the adjoining hill slopes.

Parts of this type are subject to overflow, but inundations last for short periods only.

The Hancock silty clay is a black terrace soil, which produces good yields of alfalfa, corn, and wheat. This type is inextensively developed.

The Hancock silt loam lies above overflow and is found as a bench or terrace along some of the main drainage ways of the county. It is a valuable type and well suited to all of the general agricultural crops grown in the county.

The Sarpy very fine sandy loam is developed in the Missouri River bottoms. The soil has a brownish color and produces good yields of corn, oats, and hay. It is well drained, but the danger from floods limits its agricultural value.

The Sarpy very fine sand is inextensively developed in the first bottoms of the Missouri River. It is subject to frequent overflows and greatly resembles Riverwash.

The Osgood very fine sand occupies a terrace position, but owing to the lack of organic matter has not a very high agricultural value. Sweet potatoes, melons, and cantaloupes do well on this type.

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